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Consistency Tests

ALUMINUM CONE VS. STANDARD STEEL CONE

By Carl Georgi, Technical Director, Quaker State Oil Refg. Corp.

Practically all manufacturers of lubricating greases make one or more products of a semi-fluid nature, the term semi-fluid being applied to those soap base lubricants which have A.S.T.M. penetrations in excess of 400, and which cannot, therefore, be measured on the A.S.T.M. grease penetrometer. Since it is essential to have a consistency test for control in manufacture, as well as for consumer purchase specifications, a number of methods have been devised in various laboratories for determining the consistency of these semi-fluid type greases. Among these are the Stormer and MacMichael torsion viscosimeters, Gardner Mobilometer, S.I.L. Mobilometer, and a number of other devices of similar nature. None of these methods are in general use so that the means used by various manufacturers to measure consistency of their semi-fluid type greases vary widely, and are entirely unstandardized.

In an effort to develop a simple means for determining the consistency of semi-fluid greases, the most logical procedure seemed to be a modification of the A.S.T.M. grease penetrometer. The A.S.T.M. penetrometer is in almost universal use and is recognized as a standard for determining the consistency of greases having penetrations less than 400. It seemed desirable, therefore, to attempt a modification of the standard penetrometer so as to increase its range to include greases of over 400 penetration. An aluminum penetration cone and plunger rod (Part No. 3525, Precision Scientific Company, Chicago, Illinois), having a total weight of fifty grams, was substituted for the standard brass cone and steel plunger rod weighing 150 grams. The dimensions of the aluminum cone were identical to the standard brass cone. This modification has been in use for several years in this laboratory, and has been found to serve its intended purpose of measuring the consistency of a number of semi-fluid type lubricants quite satisfactorily. While the readings obtained with the 50 gram aluminum cone and plunger have no direct relation to standard A.S.T.M. penetrations, they have proved to be of material value in controlling the consistencies of semi-fluid lubricants within predetermined limits. This modification has been found to produce consistent and reproducible results with a variety of greases having penetrations in excess of 300 A.S.T.M.

In an endeavor to secure what might be termed a "universal" penetrometer, that is, one which could be used for making tests with the standard 150 gram cone, as well as with the modified 50 gram cone, penetration tests were made on a variety of lubricating greases wherein a 100 gram weight was attached to the 50 gram aluminum cone and plunger. In this way the machine could be converted by the simple removal or addition of a 100 gram weight rather than by dissembling the penetrometer machine for removal or insertion of the respective brass or aluminum assemblies. In the first tests, the 100 gram weight was added to the aluminum cone and plunger by fastening it to the top of the plunger rod. Table I shows a few typical results secured with this set-up as compared to the standard brass cone and steel plunger rod. It will be noted from Table I that the aluminum cone, plus the 100 gram weight attached at the top of the plunger rod, did not give penetration readings adequately comparable with those secured with the standard brass cone and steel rod. In many cases other than shown on chart discrepancy ran as high as 20 to 25 points. The only explanation for these discrepancies seemed to be that the weight at the top of the plunger rod, if not centered exactly, caused binding of the plunger shaft in the guide bearings with ensuing erratic readings.

In a second attempt to make a so-called "universal" penetrometer, cone shaped weights were made and were sawed in half such that they fitted around the plunger rod inside the skirt of the cone proper so that the weight distribution was similar to the standard brass cone. Table II shows typical results secured with this set-up on a variety of greases. It will be noted that the aluminum cone and plunger, plus a 100 gram weight, gave penetration readings in close agreement with the standard 150 gram brass cone and plunger. Shown also, is the effect of plunger and cone weight on penetration, illustrating that the aluminum cone will extend the range of the grease penetrometer to include soft, semi-fluid lubricants.

The laboratories of the Texas Company (Industrial and Engineering Chemistry, Analytical Edition, Volume 13, May 1941, page 295), have also developed a modification of the standard A.S.T.M. grease penetrometer wherein they have utilized a counterbalanced weight system to decrease the effective weight of the standard 150 gram cone and plunger. This modification apparently gives results quite similar to the one described above, and represents another means of broadening the usefulness of the A.S.T.M. Penetrometer and penetration test method.

Sufficient work has been done in a number of laboratories with modified A.S.T.M. grease penetrometers, to indicate that simple modifications of the instrument provide a worthwhile means for measuring the consist-

ency of semi-fluid type lubricants. The experience of this laboratory has been related not with the idea of advocating the aluminum cone as the ideal method for measuring the consistency of semi-fluid lubricants, but rather to point out a problem which most lubricant manufacturers have, and which, because of its importance, deserves study by the N.L.G.I. with the ultimate purpose of standardizing a consistency test procedure for an important class of lubricants.

TABLE I

COMPARISON OF BRASS AND ALUMINUM CONES

	A.S.T.M. Brass Cone & Steel Plunger Rod (150 grams)	Aluminum Cone & Plunger Rod plus 100 gram weight on top of plunger rod (Total wt. 150 grams)
Calcium Base Grease	345	358
Calcium Base Grease	360	355
Calcium Base Grease	194	209
Aluminum Base Grease	318	329
Soda Base Grease	244	243

TABLE II

EFFECT OF PLUNGER AND CONE WEIGHT ON PENETRATION

WEIGHT OF ALUMINUM	gms.	gms.	gms.	Standard A.S.T.M.
Plunger and Cone	50	50	50	Brass Cone and Steel Plunger Rod
Added Weight (InsideCone)	0	50	100	
Total Weight	50	100	150	150 gms.
Calcium Base Grease	256	325	353	351
Calcium Base Grease	150	206	240	240
Aluminum Base Grease	260	302	329	327
Soda Base Grease	170	230	275	277
Semi-Fluid Calcium Base	302	380	Too Soft	Too Soft
Semi-Fluid Calcium Base Grease	365	Too Soft	Too Soft	Too Soft

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H. R. WOLF — General Motors Corp.

"DEVELOPMENT OF WORK FACTOR FOR GREASES"
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"COMMITTEE ACTIVITIES AND THEIR RELATION TO THE NATIONAL DEFENSE EFFORT"
L. C. WELCH, *Chairman,* Lubrication Committee, A. P. I.

"DISCUSSION OF ANTI-FRICTION BEARING LUBRICANTS"
O. L. MAAG — Timken Bearing Co.

"COST ACCOUNTING AS APPLICABLE TO THE GREASE INDUSTRY"
E. V. MONCRIEFF — Swan-Finch Oil Corp.

"CONSISTENCY OF GREASES AND OILS AT LOW TEMPERATURES"
G. CAUFFMAN — The Texas Co.

"IMPORTANCE OF SOUND ACCOUNTING METHODS AND WHAT THEY MEAN TO MANAGEMENT"
Speaker from the American Institute of Accountants

5 P. M.—COCKTAIL HOUR—TOWER BALL ROOM

MONDAY EVENING ANNUAL BANQUET—7 P. M.

ENTERTAINMENT DELUXE

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"MODERN PACKAGING OF GREASE LUBRICANTS"
By C. W. BROWNE — Editor *Modern Packaging*

"GREASE CONSISTENCY INVESTIGATION"
C. M. LARSON-C. L. KNOPF — Sinclair Refg. Co.

"CHEMISTRY OF ADDITIVES FOR PETROLEUM PRODUCTS"
DR. C. F. PRUTTON — Lubri-Zol Corp.

"BALL BEARING LUBRICATION"
H. M. FRASIER — International Lubricant Corp.

DISCUSSION OF DEFENSE ACTIVITIES AS RELATED TO THE GREASE INDUSTRY
LT. COL. M. B. CHITTICK — U. S. Army Chemical Warfare Division

AFTERNOON SESSION

Annual Business Session for Active Members Only, Report of Committees,
Election of Directors. Adjournment.

STEVENS HOTEL - CHICAGO, ILL.
SEPTEMBER 29, 30, 1941

*Engine Crankcase Temperature Ranges**

By J. HOWARD PILE, Chek-Chart Editorial Director

Modern internal combustion engines are made and designed very exactly as to balance, clearance, compression and all other details. It is necessary that motor oils be used in accordance with expected atmospheric temperatures in order to insure the fullest degree of lubrication and at the same time provide grades of oils that will permit a minimum cranking speed of 50 rpm.

* * *

The grade of crankcase oil to be used depends upon the lowest atmospheric temperature to be encountered during the period that the car will be driven on a filling of crankcase oil.

* * *

When CHEK-CHART brought out its first wall chart in 1933 almost every car and truck manufacturer had an entirely independent set of temperatures for which they specified different grades of oils. CHEK-CHART, at that time brought the attention of car makers to the need of standardization of temperature ranges and set up ranges based on the weighted average of what car makers were already doing. This set of ranges became the informal standard of the industry and was used by most car makers and most oil companies. In 1939 the Lubricants Division of the Society of Automotive engineers canvassed the entire automotive industry and, with minor modifications, made these ranges an SAE standard as they now appear in the 1941 SAE Handbook, page 487. In January, 1941, the tractor division accepted these ranges.

At present, with the exception of one tractor maker and one car manufacturer, the entire industry uses these ranges, and all oil companies use them so that the wishes of the manufacturer can be exactly met by the retail user. The two companies not yet using the standards have ranges varying only to a slight degree and will probably change later.

Here are the ranges as carried in the heading of the CHEK-CHART Wall Chart:

CRANKCASE			
Extreme Summer Temperature	Use the grade of oil that will insure easy starting at the lowest expected atmospheric temperature.		
Over 90° F.	Lowest Anticipated Temperature		
	+32° F.	+10° F.	−10° F.

Over 90° — Use grades recorded in this column where atmospheric daytime temperatures for the next 1000 miles of driving are expected to be consistently above 90°. This will take care of the highest temperatures to be encountered under any conditions and all hard driving. The fact that the temperatures may occasionally drop below 90° or that night time temperatures may be below 90° does not affect the recommendations. Such temperature conditions may be found in certain parts of the Midwest, the South, and other locations during July and August. A locality such as New York or Chicago where the thermometer only occasionally goes above 90° should not use this range normally.

Above + 32° — Use grades recommended in this column where the atmospheric temperature, day or night, is not expected to go below freezing during the next 1000 miles of driving. Short periods of a few degrees below freezing may be disregarded. This range assumes that temperatures will not normally get much over 90° but may do so for moderate intervals.

Above + 10° — Use grades recommended in this column when day or night temperature is not expected to go below + 10° during the next 1000 miles of driving. In this range, normal temperatures may be expected as high as 70° or 80° and for an occasional short period a few degrees below + 10° will not be harmful if the oil does not get too stiff to get the engine started. Prolonged temperatures below +10° should take the next lower range.

Above − 10° — Use grades recommended in this column when day or night temperature is not expected to go below − 10° for the next 1000 miles of driving. In this range the temperature may run as high as 40°.

EXTREME COLD

For temperatures consistently below −10° car and truck manufacturers usually record dilution of the lightest grade oil with 5 to 10% of kerosene. Most oil companies, however, do not favor dilution because trouble may occur if the temperature rises. For such extreme conditions, select an oil which has a viscosity which will permit an engine cranking speed of at least 50 rpm at the lowest temperature to be encountered and which has a pour test below this point so that the oil will remain fluid.

GENERAL CONDITIONS

Recommendations in the columns may be safely used under all conditions where the

(Continued on page 5)

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Engine Crankcase Temperature Ranges

(Continued from page 4)

engine is in good mechanical condition. If engine parts are worn, it may be desirable to use the next heavier grade in order to reduce oil consumption. Extreme high speed driving for long periods may also make it desirable to go to the next heavier grade of oil.

Except for special conditions, as outlined above, best results will be obtained by following recommendations as given by manufacturers and as shown in CHEK-CHART Wall Charts and lubrication diagrams.

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(Continued on page 8)

Performance Specifications for Greases[1] *

By ROBERT C. ADAMS[2] AND HARRISON E. PATTEN[2]

SYNOPSIS

Special testing equipment and methods for its use are described in connection with the performance specifications which are being developed by the Navy. Plasticity, leakage, bleeding, and resistance to oxidation are measured under accelerated or simulated service conditions and the specification requirements are based upon these results instead of upon composition. Performance testing permits the identification and purchase of superior greases with reduction in costs of lubrication despite some increase in unit cost.

The Navy has known for several years that the specifications under which the purchases of lubricating greases are made are faulty and has been searching for an improved method of specification. Increasing speeds, bearing loads, tooth pressures and operating temperatures have increased the demands on lubricants, in many cases beyond the point where simple composition specifications give assurance of satisfactory material. For the lubrication of some machines and accessories, the demands of which are particularly severe, lubricants recommended by the manufacturer of the machinery have been purchased. This system of temporizing has resulted in the growth of an extensive list of proprietary lubricants, with the attendant complication of maintaining stocks of twenty or thirty special lubricants at Naval bases and yards and on supply ships and aircraft carriers. A particularly objectionable feature has been the necessity of stocking several different lubricants for similar machines from different manufacturers.

DESIRABILITY OF PERFORMANCE TESTS

Government Departments, particularly the Navy, have long favored the purchase of materials on a service life or work-factor basis. In the case of lubricating oils, this method has been so far developed that the work factor is applied to the manufacturer's bid price with the result that the Government instead of purchasing lubricating oil buys lubrication with oil. Work on greases has been in progress at the Engineering Experiment Station for several years and it now appears that the specification of greases on the basis of performance instead of the former specification on the basis of composition and physical properties is possible. The work is by no means completed, but a description of the special apparatus and the results which have been obtained to date should be of interest to both producers and consumers of greases.

The object of these methods is to measure the working lubricating properties of grease without regard to the materials of which it is composed, the manner of manufacture, or its history prior to receipt. While all of these affect its properties, the evaluation of such diverse factors is impracticable. Naturally the first efforts were directed toward lubricants for apparatus in which the greatest difficulty had been encountered.

HIGH-TEMPERATURE GREASE

The first of these was the specification of lubricants for high-temperature service, in situations where grease would be exposed to temperatures of 300F. or more. An apparatus was designed and built, Navy Grease Machine 1938, Fig. 1, in which a standard ball bearing, filled with the test lubricant, can be operated at controlled temperature and speed, while the torque is measured. All else being equal, it is reasonable to believe that the grease with the lowest torque

(Continued on page 7)

[1] The opinions expressed in this paper are those of the authors and are not necessarily official opinions of the Navy Dept. or the Engineering Experiment Station.

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* Courtesy American Society for Testing Materials.

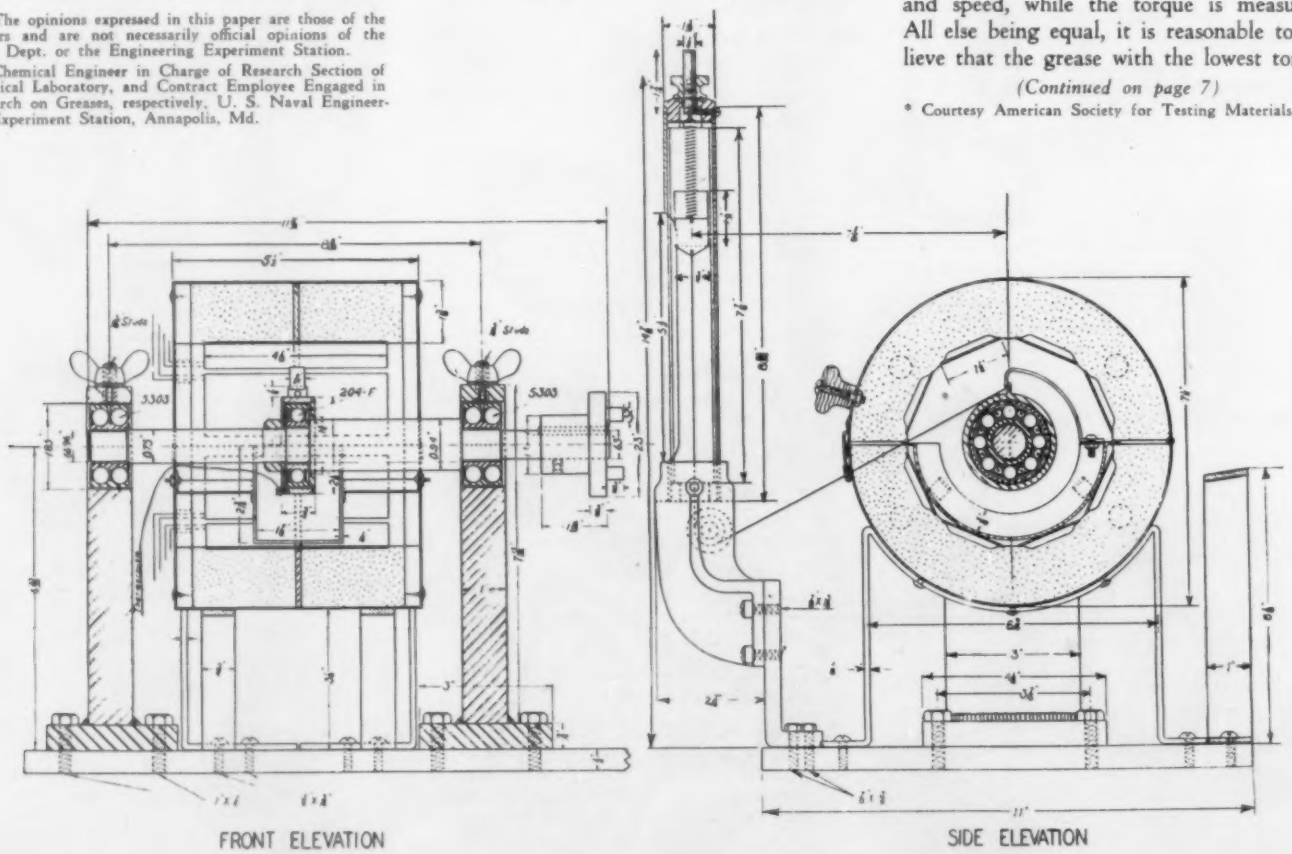


FIG. 1 —Navy Grease Machine, 1938.

and therefore the lowest friction loss would be the most suitable. Many precautions are necessary in order to obtain reproducibility. The first is the maintenance of a uniform filling of the test bearing with grease. To accomplish this a filling apparatus, called the Navy Bearing Packer, Fig. 2, was made, with which all voids in a No. 204 open bearing can be filled. The amount of grease loaded into the test bearing by means of the bearing packer is reproducible within 1 per cent.

FIG. 2.—Navy Bearing Packer.

Principal variables affecting the torque measurements, in addition to the character of the grease, are temperature, amount and distribution of grease in the bearing, speed of rotation, and time since the start of the test. The last is important because of the thixotropy of the grease, since during working its plasticity is constantly changing. Time can be measured, but not altered or reversed. In order to obtain reproducible results, it is necessary to collect all data in the form of torque-time curves. All other variables can be maintained constant throughout the test run.

At the start of the test run the grease is packed into 100 per cent of the voids of a weighed, No. 204, eight-ball bearing without grease shields, and the filled bearing is again weighed. The outer race of the test bearing is clamped into a brake drum and the assembly locked on the shaft of the Navy Grease Machine with the shaft through the inner race, and the brake drum connected to the torque-measuring spring. The motor previously has been adjusted to rotate at the desired speed and the test temperature is set. The motor is started and the first excursion of the spring is read as the initial torque, with readings thereafter at first frequently, then at increasing intervals, for 1 hr. Although the torque has been observed to decline continuously, at a decreasing rate, for as long as 16 hrs., the torque-time curve obtained in 1 hr. is characteristic. At the end of the run the bearing is removed, excess grease is wiped off the faces of the race, and the bearing weighed. The difference in weight is called leakage and is calculated to percentage of the original grease charge.

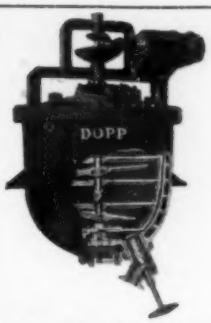
(To be continued)

Heads Pennsylvania Company

Russell N. Keppel has been named president and G. E. Bubar and H. W. Chapin have been elected directors of the Standard Oil Company of Pennsylvania.

Mr. Keppel joined the Jersey company nearly 21 years ago to direct personnel education and training activities at the Bayonne refinery. Interested in sales, he moved into that department in 1932 and successive steps brought him to the position of regional manager for the New Jersey, Pennsylvania and Delaware-Maryland and District of Columbia territories from which he succeeded to the presidency of the Pennsylvania company.

R. N. Keppel



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